Extending Satellite Remote Sensing to Local Scales: Minnesota Experience with IKONOS Data

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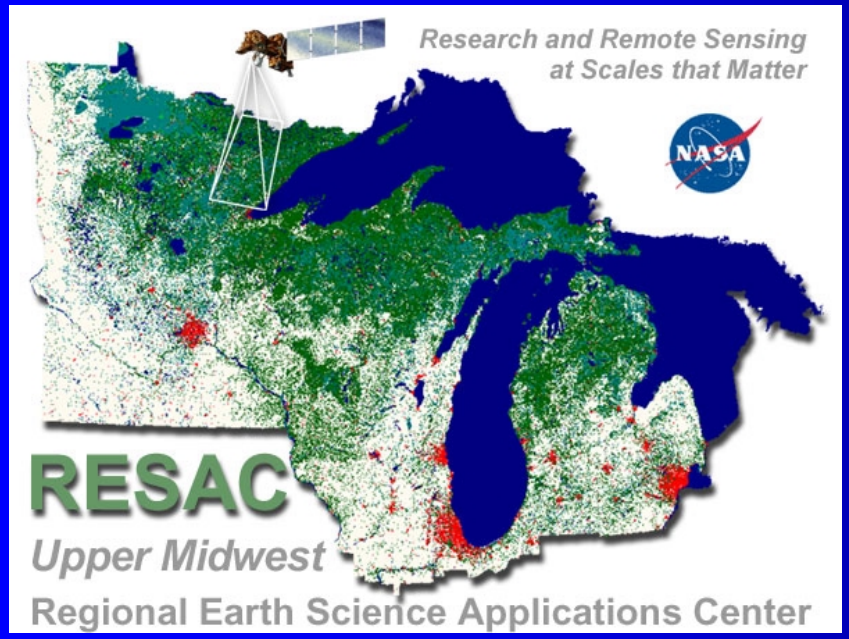
College of Natural Resources

Remote Sensing Laboratory

Project Affiliations



RESAC: The Upper Midwest Regional Earth Science Application Center

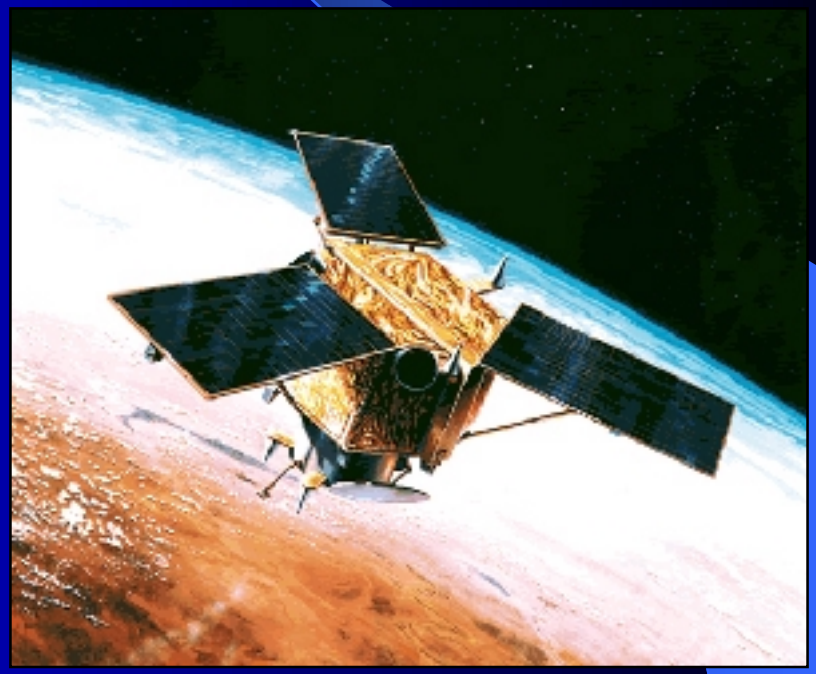
http://resac.gis.umn.edu

FFARS: Integrating Satellite Remote Sensing into Forest Inventory and Management (eForest)

http://eforest.gis.umn.edu

Objective

Evaluate the potential of IKONOS high-resolution satellite imagery for mapping and analysis of land and water resources at local scales in Minnesota

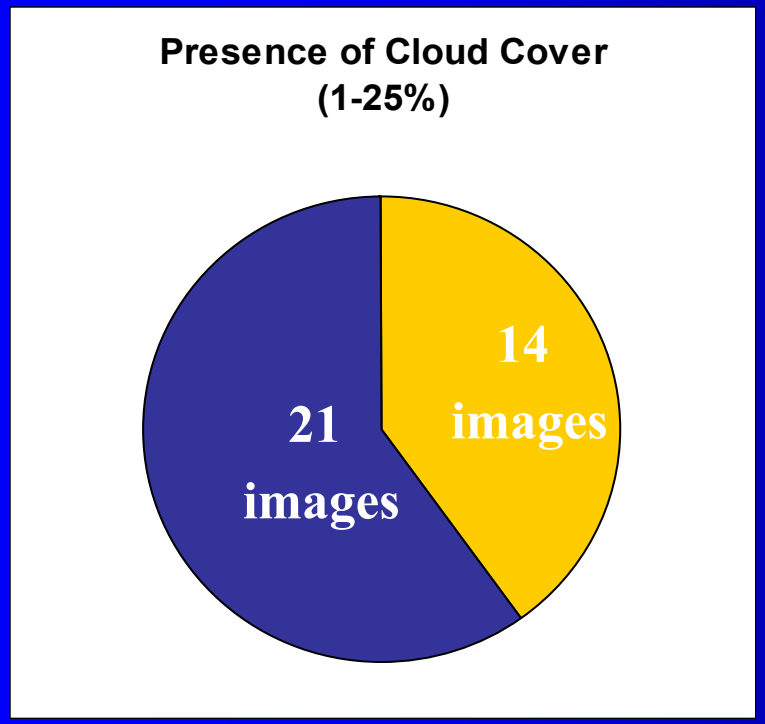


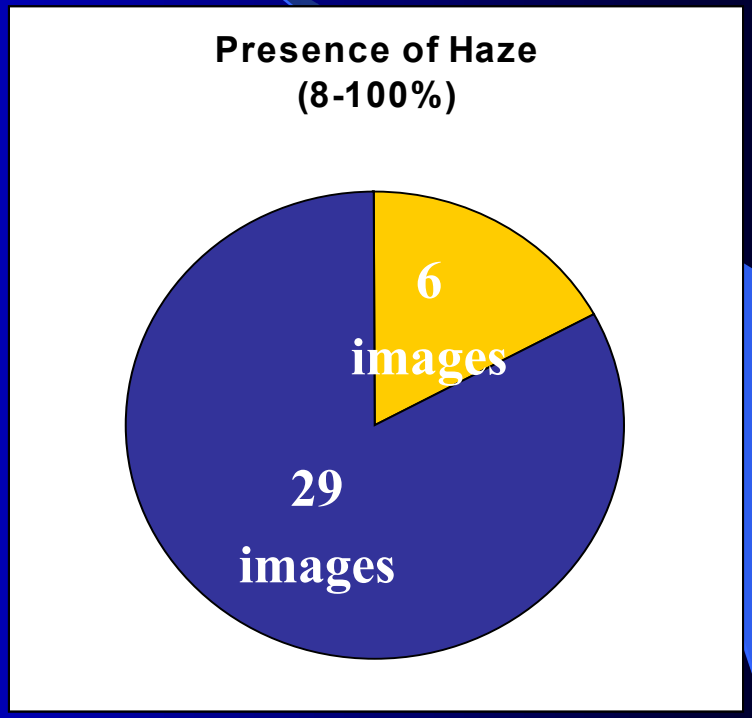
Summary of Data Request

- **36 scenes approved, 34 delivered**
  - *Plus one purchased directly from Space Imaging*
- **Specifications requested**
  - *Multispectral and panchromatic bands*
  - *Standard georeferencing*
  - *0 - 10% cloud cover (one task extended to 20%)*
  - *Any view angle*

Data Quality Overview

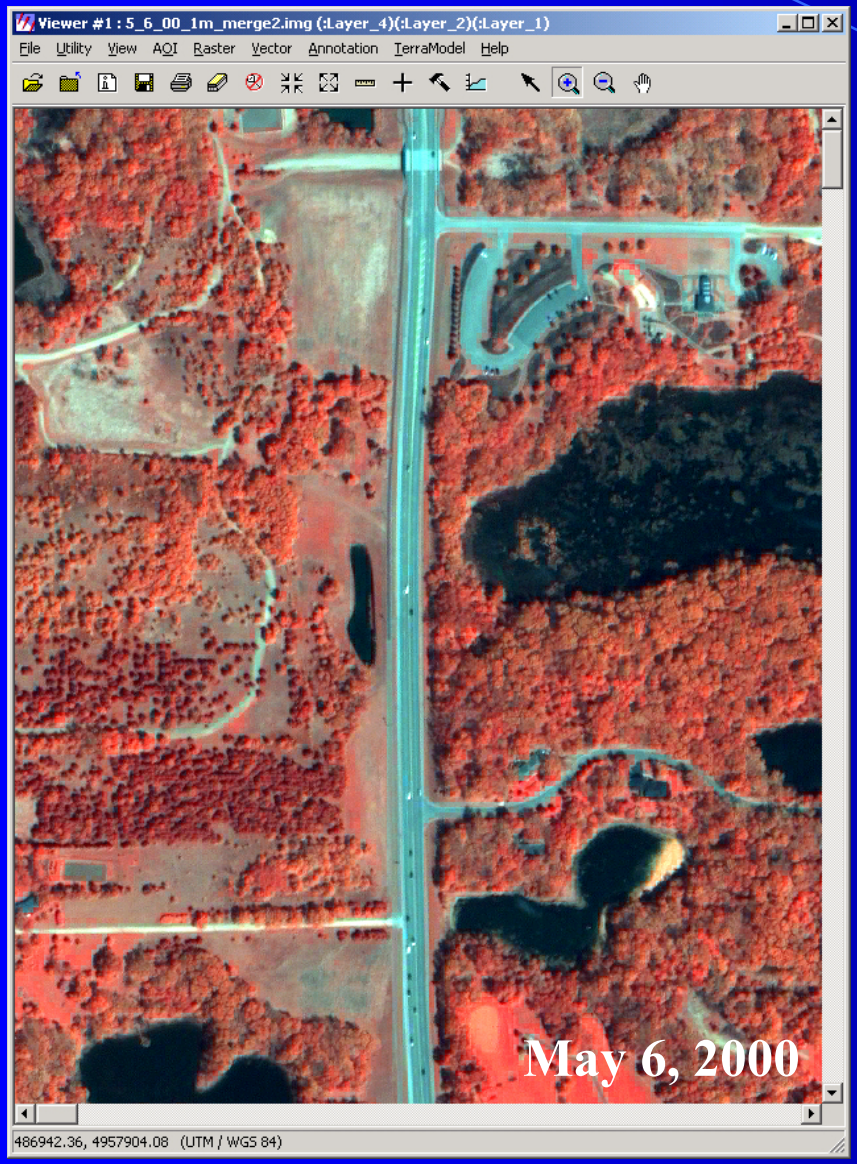
U. of Minnesota IKONOS holdings: 35 images total



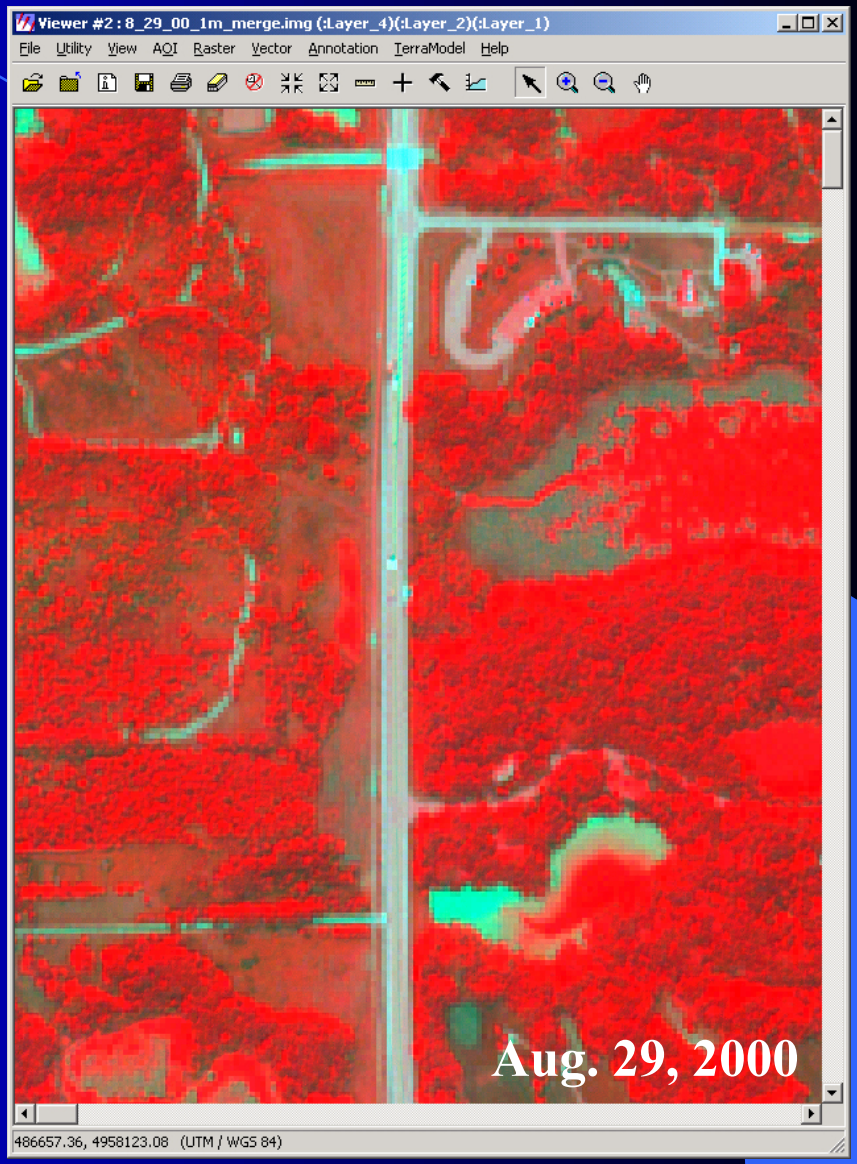


17 of 35 images were clear of clouds and haze

Data Quality Overview



Successful Resolution Merge



NIR sharpened, other bands are not

Data Quality Overview

- **Resolution Merge (using ERDAS PC1 model)**
  - *18 scenes generate acceptable resolution merge products*
  - *8 have a common problem (NIR band is sharpened, others are not)*
  - *5 scenes have unknown problems with resolution merge*
  - *4 not attempted*

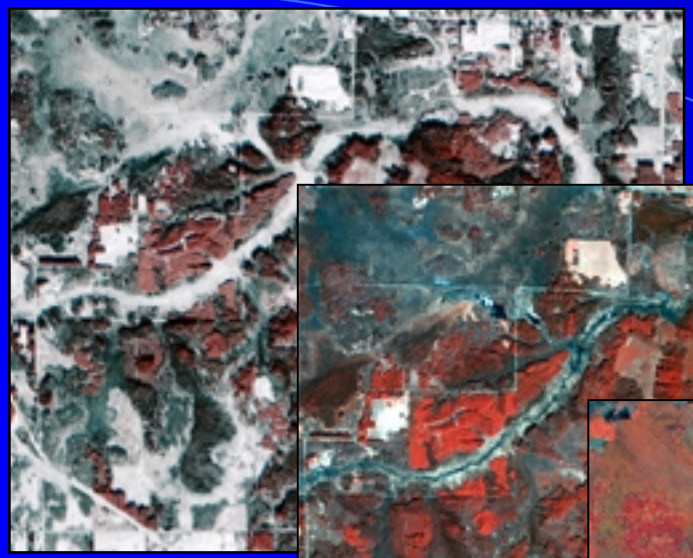
Land and Water Resource Application Examples

- Forest cover type mapping
- Extent and severity of storm damage
- Urban land use change
- Classification of lake water quality
- Agricultural crop management

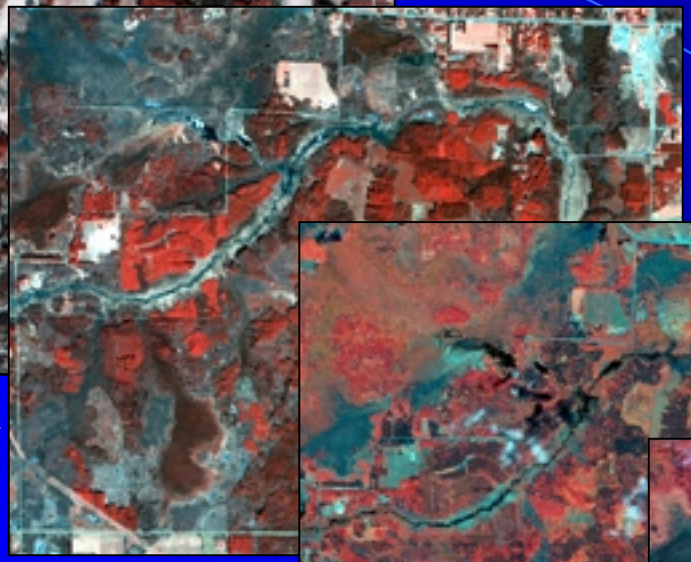
Forest Cover Type Mapping

- **Location:** University of Minnesota Cloquet Forestry Center
- **Acquisition:** Multitemporal sequence of five image dates, February-October
- **Objective:** Support forest cover type mapping and management

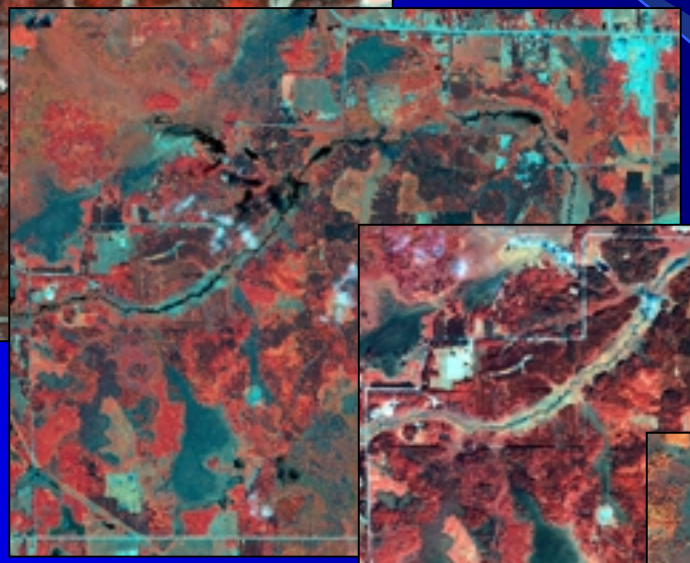
Multitemporal sequence



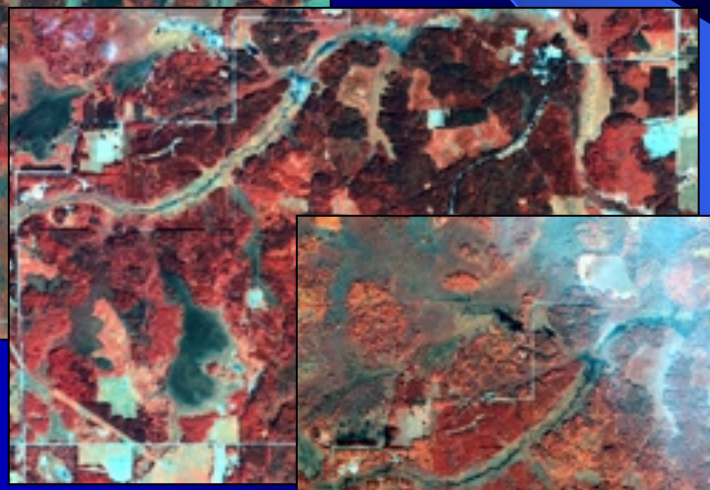
February



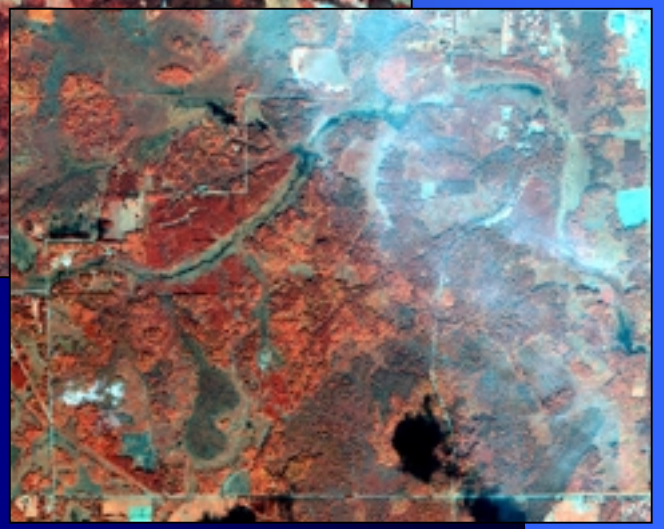
April



June



August



September

University of Minnesota
Cloquet Forestry Center

Pan-sharpened Image, August

Forestry Field Applications

- Use IKONOS imagery for on-the-ground, visual interpretation
- Deliver geospatial data and GIS/GPS capabilities on new hand-held computers to field foresters

Extent and Severity of Storm Damage

- **Location:** Boundary Waters Canoe Area and Wilderness (Northeastern Minnesota)
- **Acquisition:** Large area coverage, 18 images
- **Objective:** Analysis and characterization of the impacts of an exceptionally severe downburst-producing thunderstorm

Effects of July 4, 1999 Storm

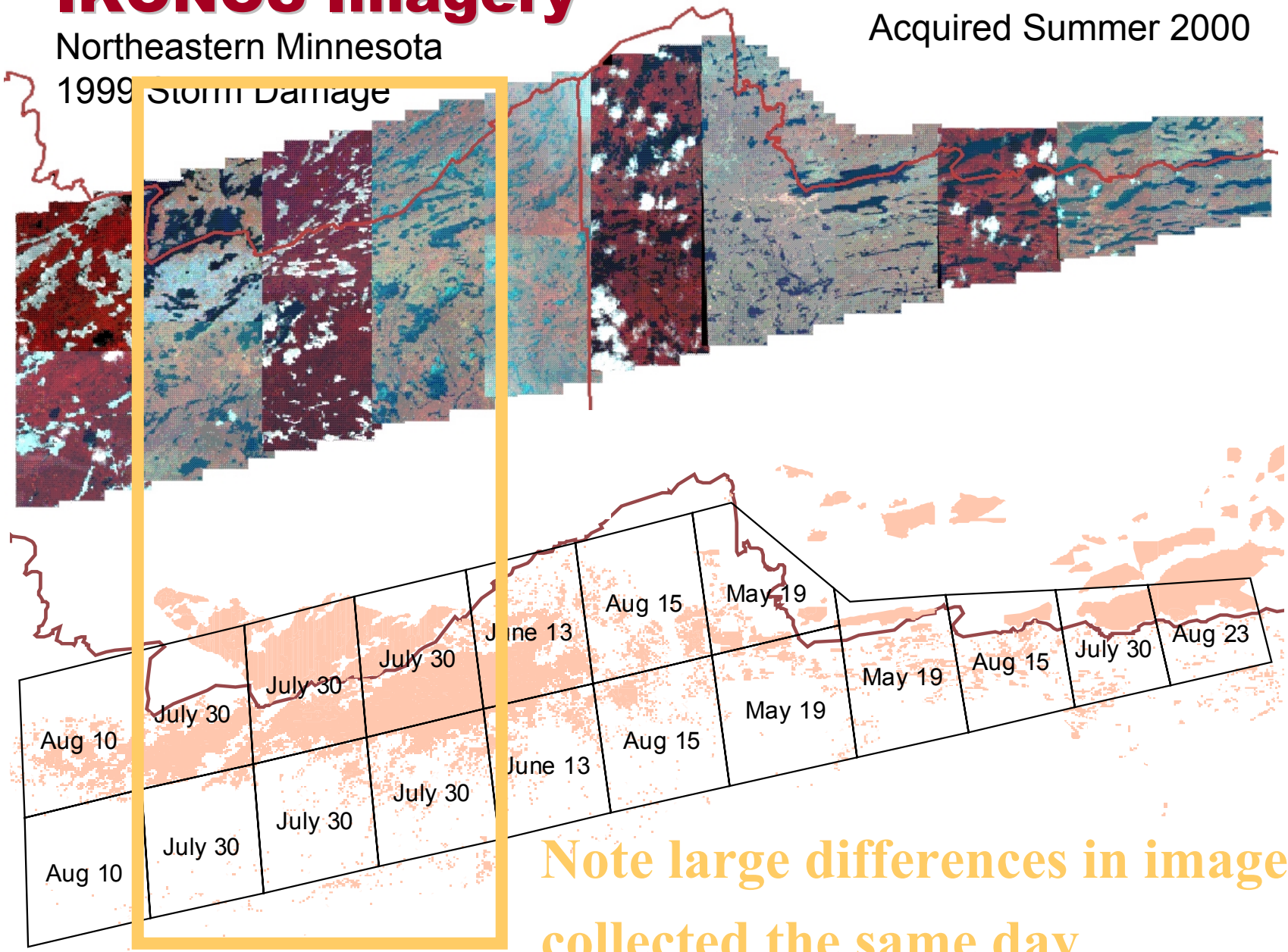
- 500,000 acres of southern boreal forest blown down
- Damage concentrated along northeastern Minnesota, southern Canada border
- Tough management decisions given wilderness status of lands
- High level of public interest
- Many research opportunities

IKONOS Imagery

Northeastern Minnesota

1999 Storm Damage

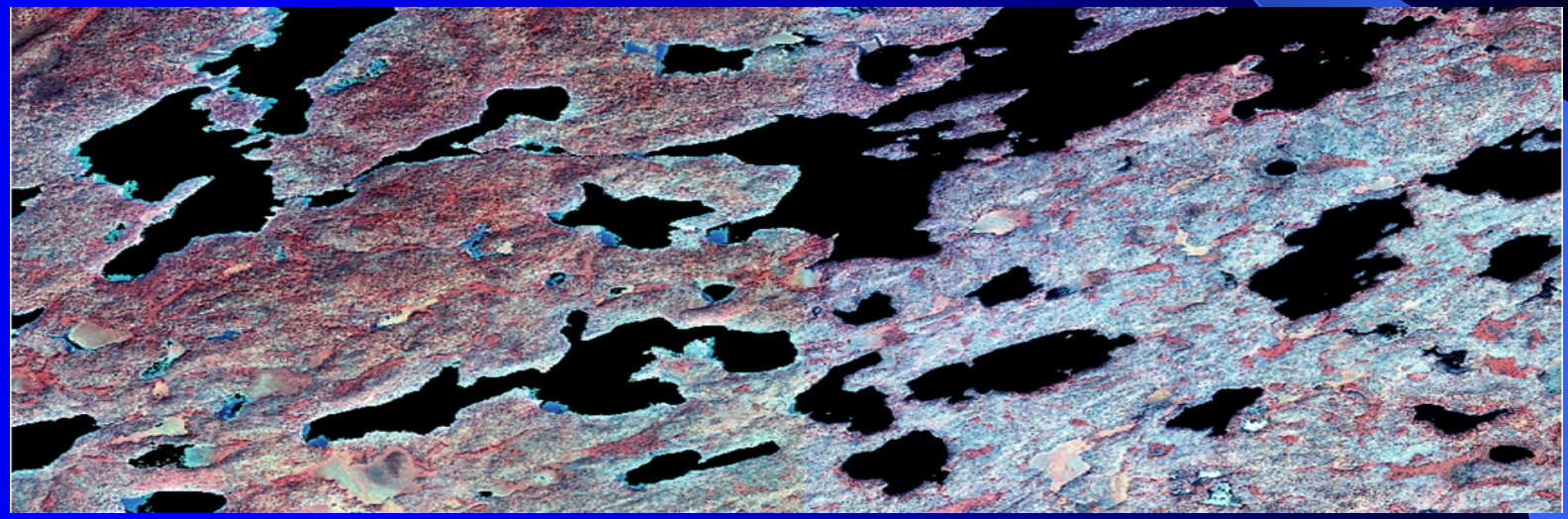
Acquired Summer 2000



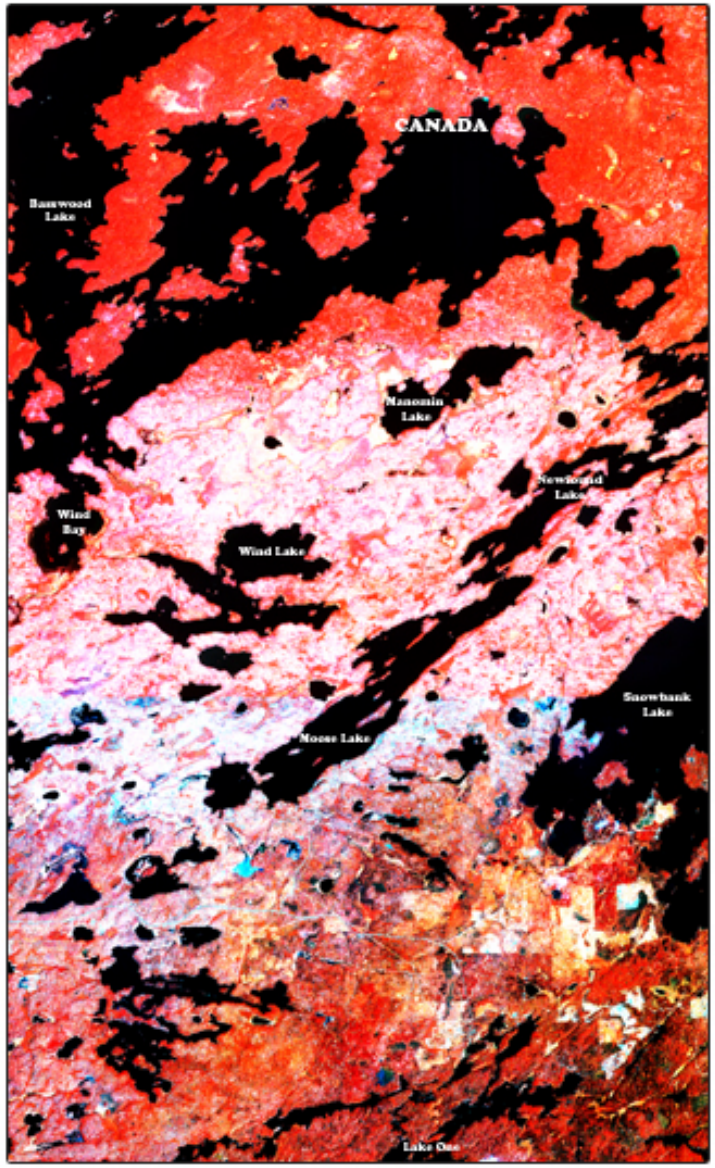
Note large differences in imagery collected the same day

Raw Data

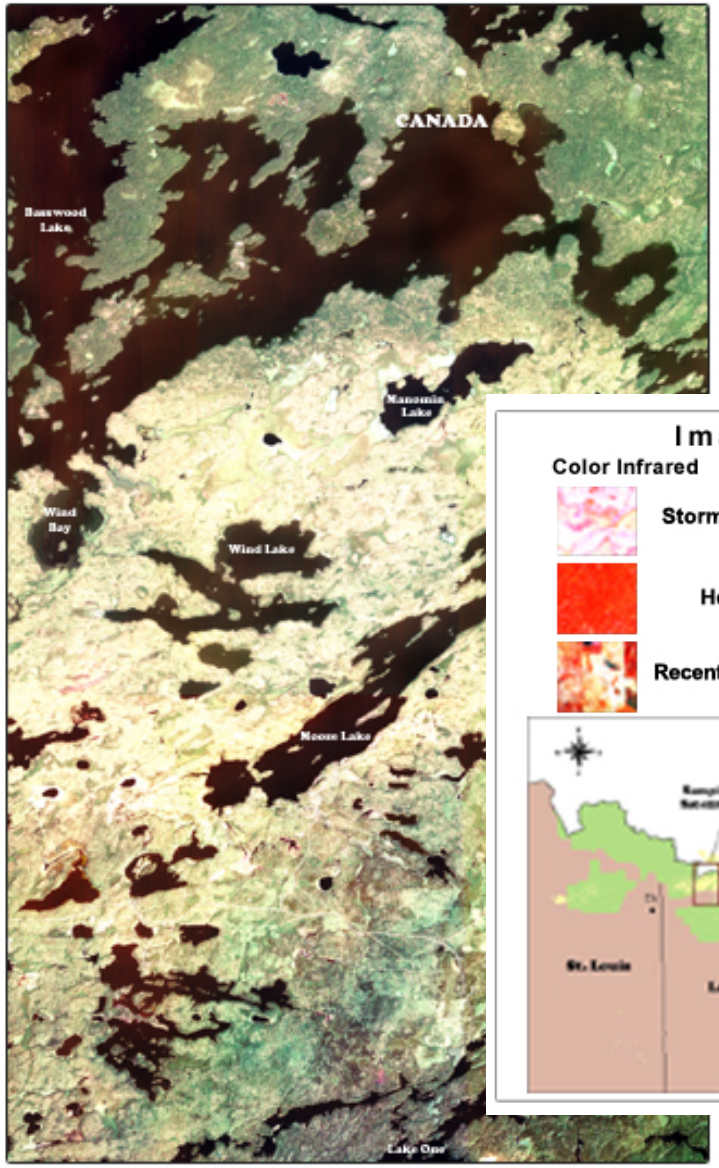
Unsupervised



Unsupervised classification to remove bidirectional reflectance effects in lakes yields an improved product for analysis of forest damage



Color Infrared View *Healthy vegetation appears bright red*



Visible Color View *Healthy vegetation appears green*

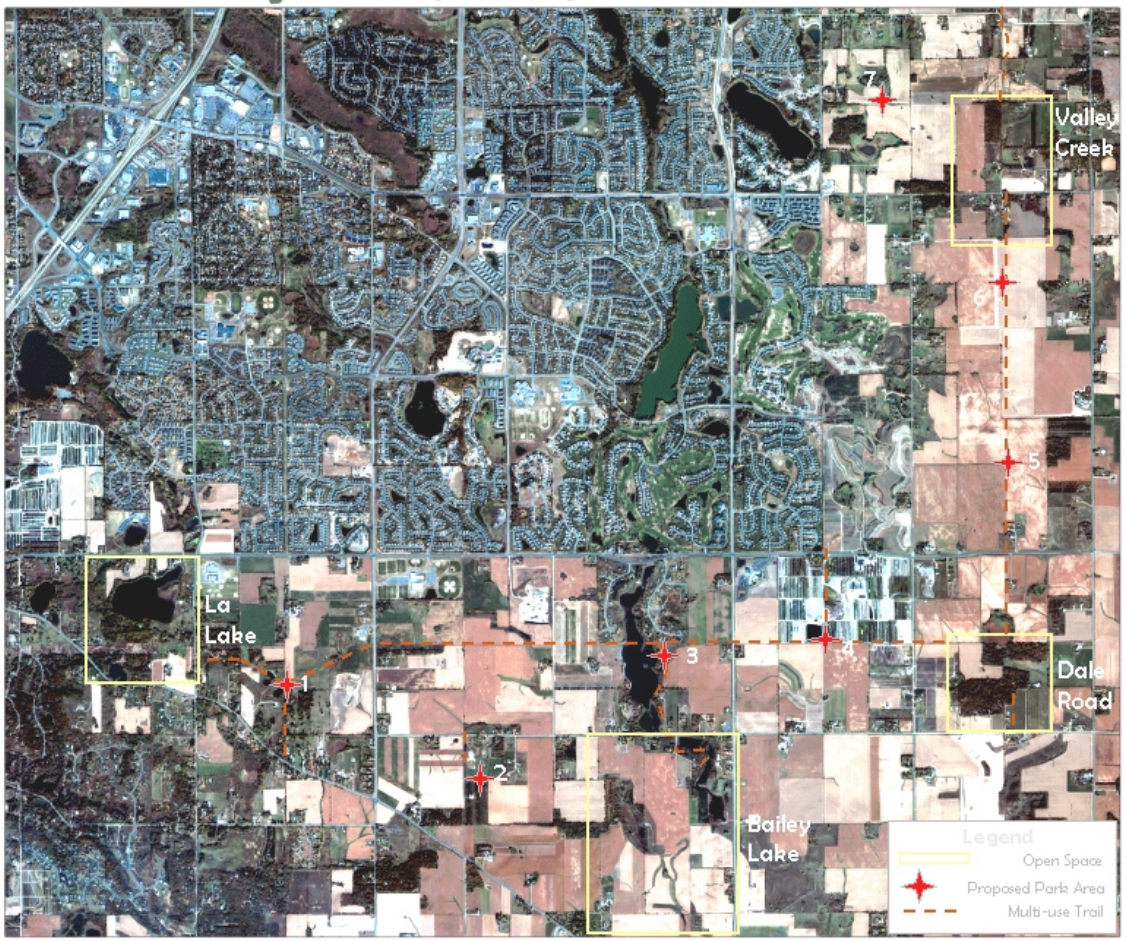
Urban Land Use Change

- **Location:** City of Woodbury (suburb of St. Paul, Minnesota)
- **Acquisition:** Two date sequence
- **Objective:** Evaluate potential of high resolution imagery for mapping land use in a rapidly developing urban area

Urban planning with IKONOS

CITY OF Woodbury

Open Spaces, Parks, and Greenways Proposal 2000



Imagery for this project provided by the Upper Midwest RESAC

The goals of the Upper Midwest Regional Earth Science Applications Center are to:
- Evaluate the long term sustainability of the region's natural resources as a basis for the regional economy, quality of life, and well-being of the region's citizens.
- Support the immediate and local resource management needs of decisions makers and stakeholders.

For more information, see http://resac.gis.umn.edu

Imagery acquired October 9, 2000

Prepared by:

Natural Resources and Environmental Studies 4195

College of Natural Resources - University of Minnesota

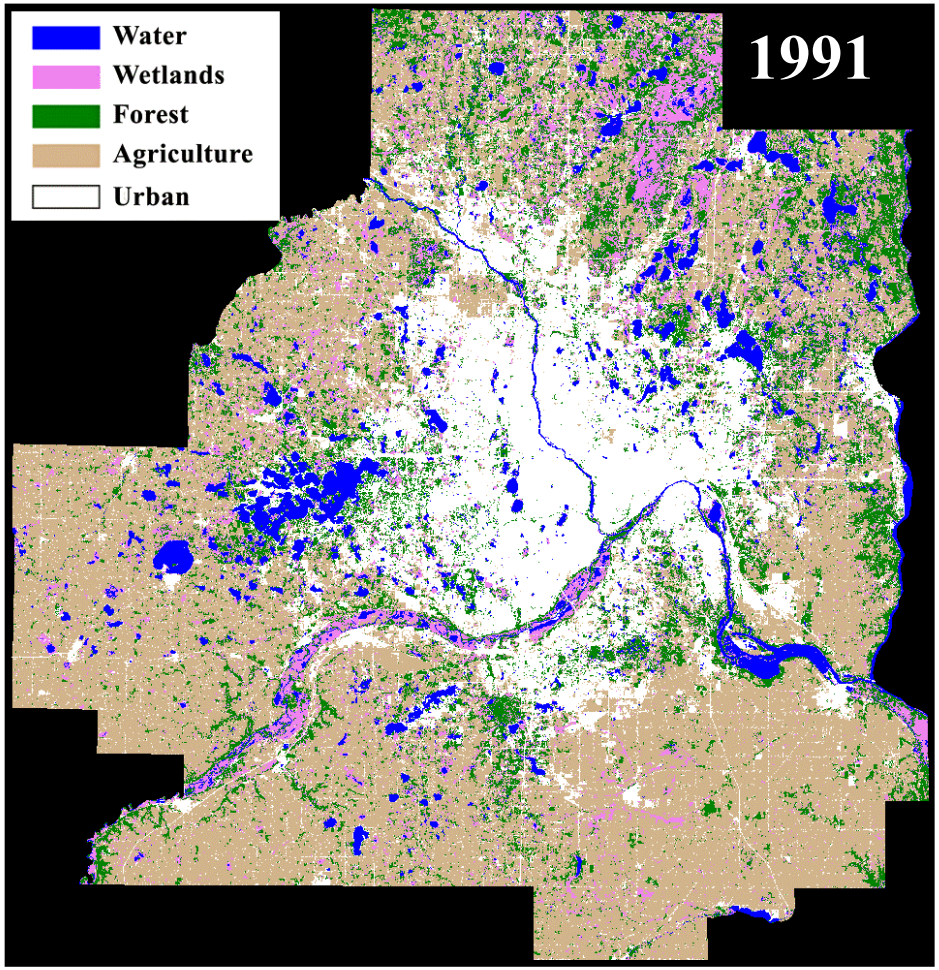
Space Imaging IKONOS

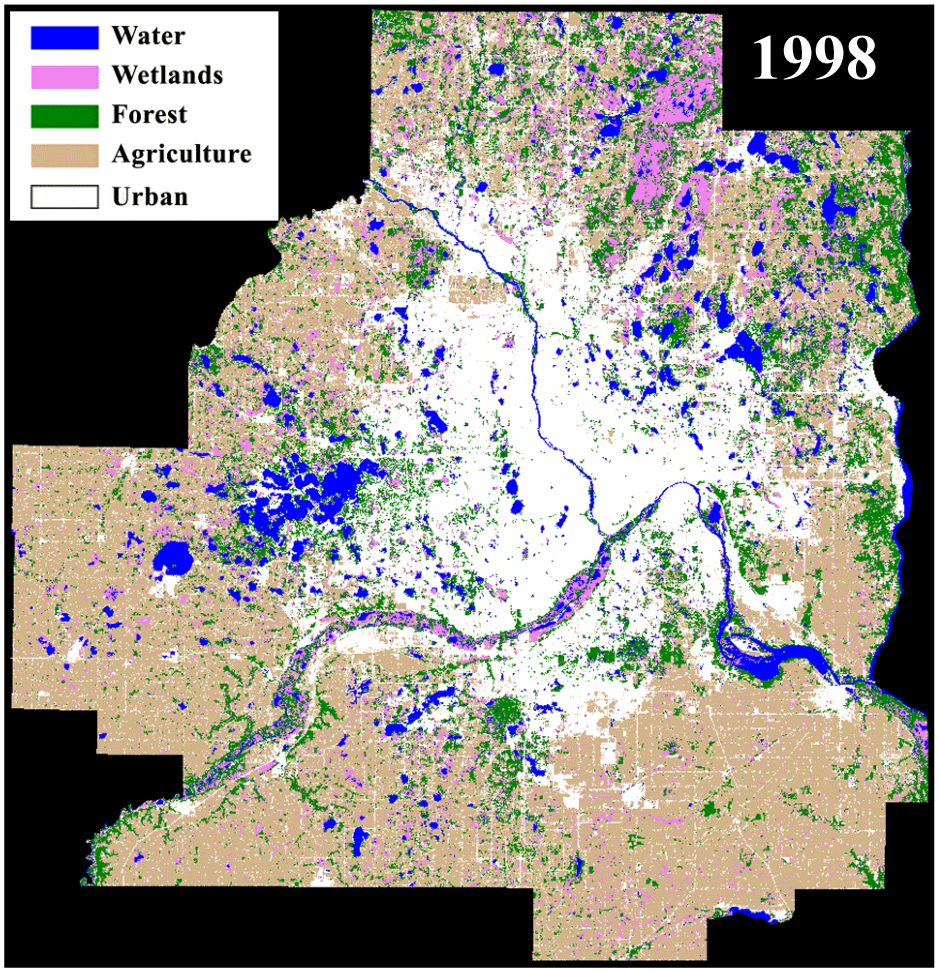
High Resolution Satellite Imagery

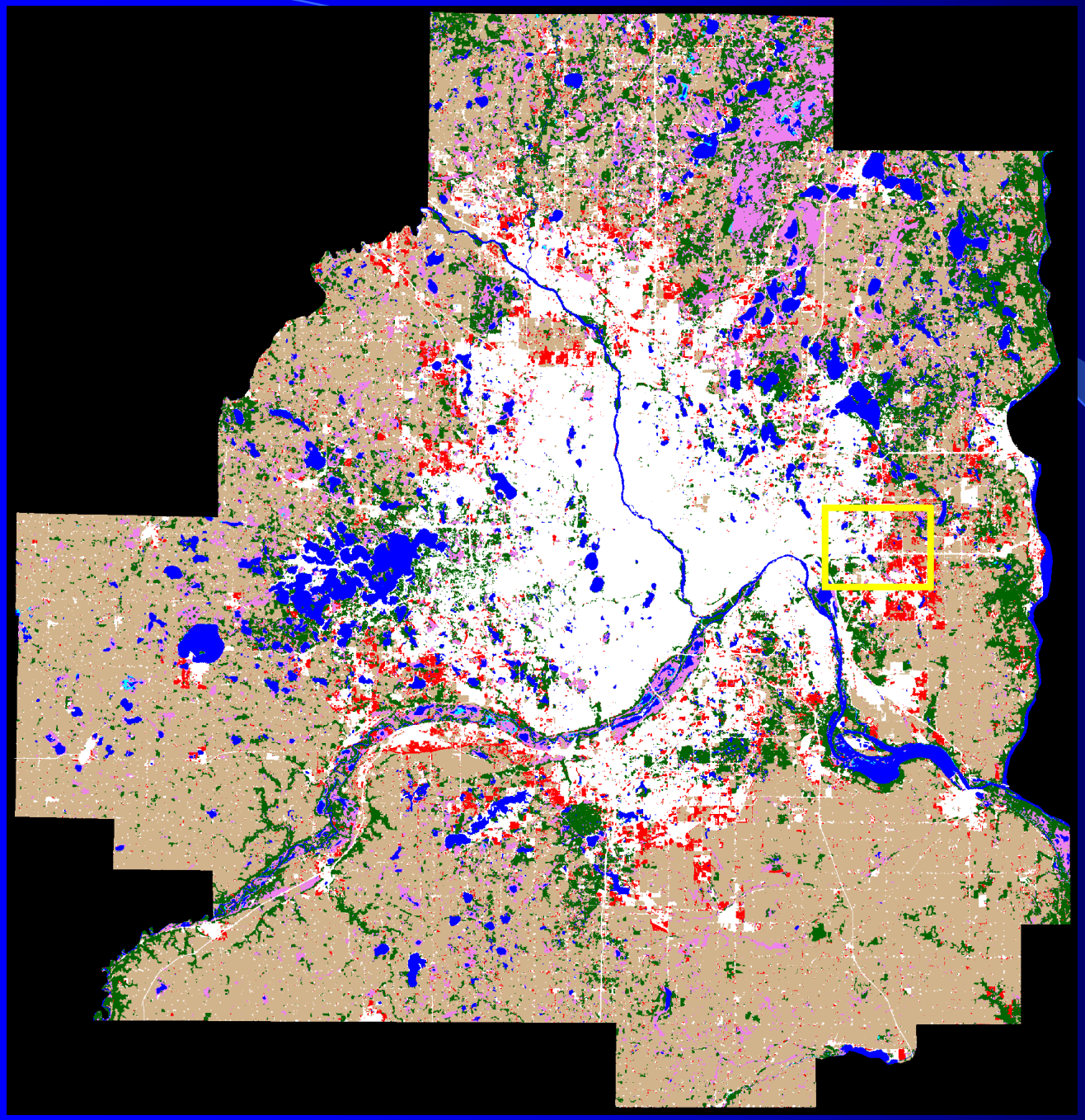
Quick Facts

Orbit period: once every 98 minutes
Revisit frequency: 3 to 4 days
Image scene size: 11.3 km by 11.3 km
Panchromatic resolution: 0.82 meter
Multispectral resolution: 3.28 meters
Cost: $12/sq km pan, $12/sq km multi
Minimum order: $3000.00

Landsat Land Cover Maps of 7-County TCMA



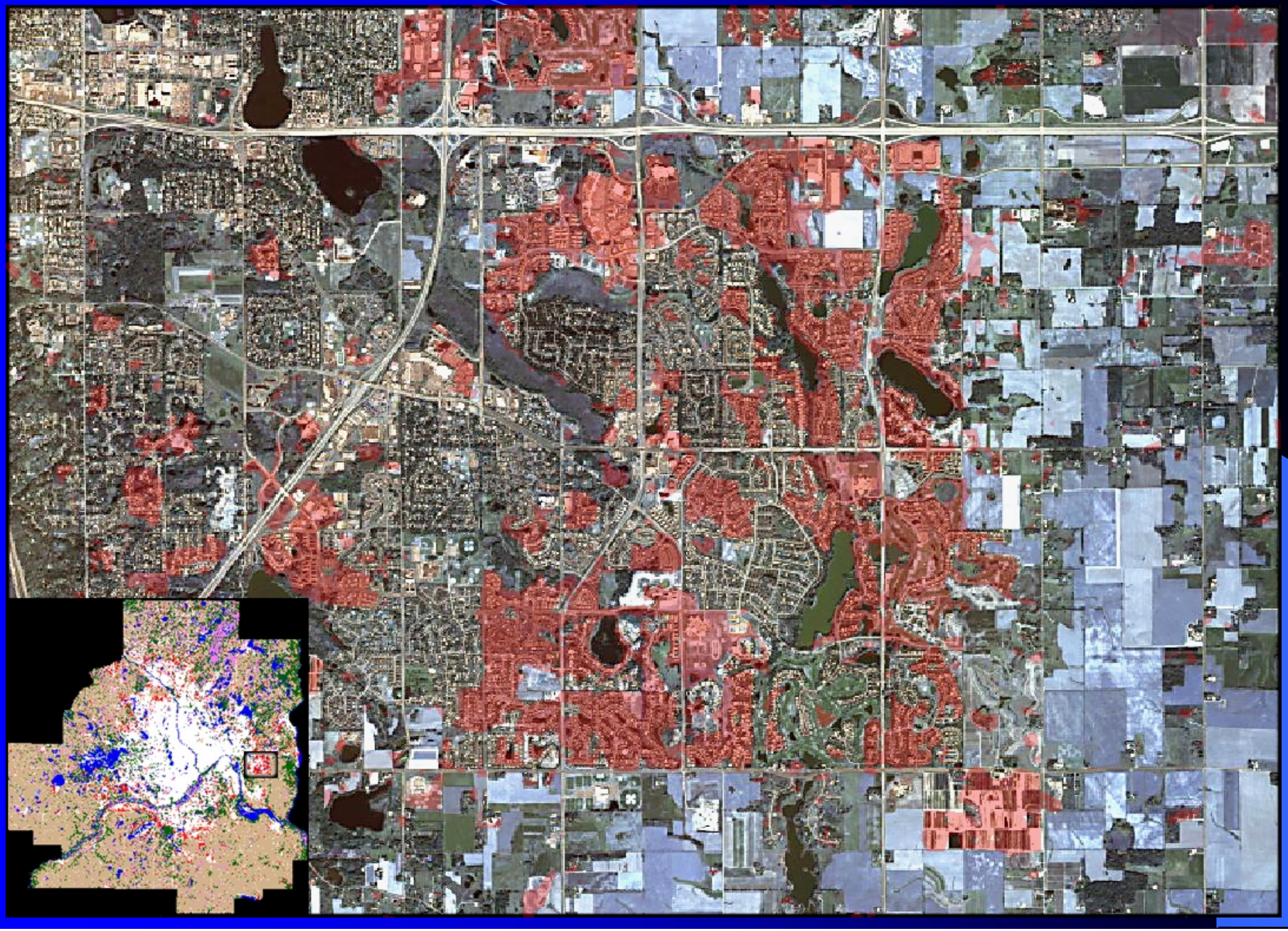




Change between 1991 and 1998

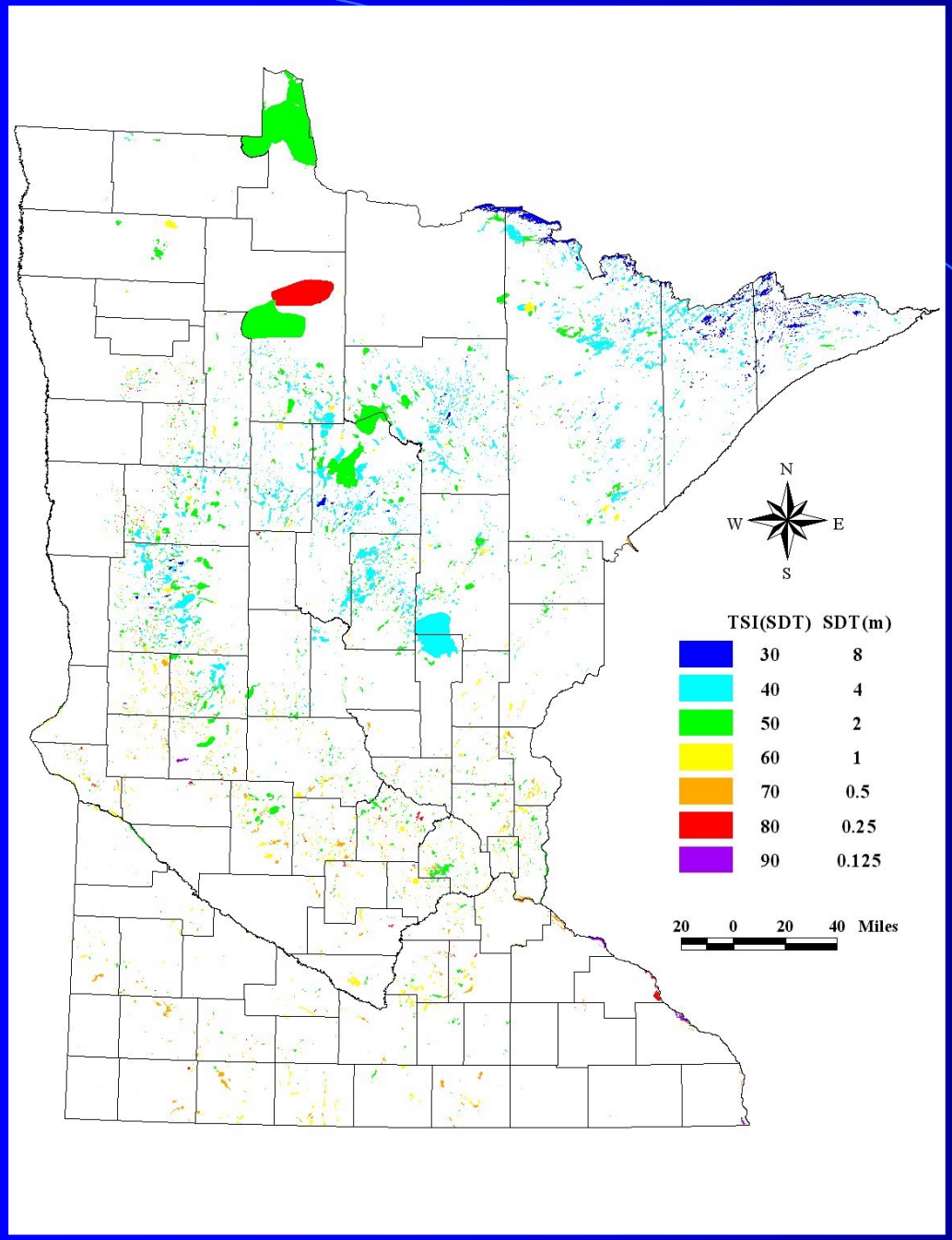
Rural to developed

Landsat change map over IKONOS image



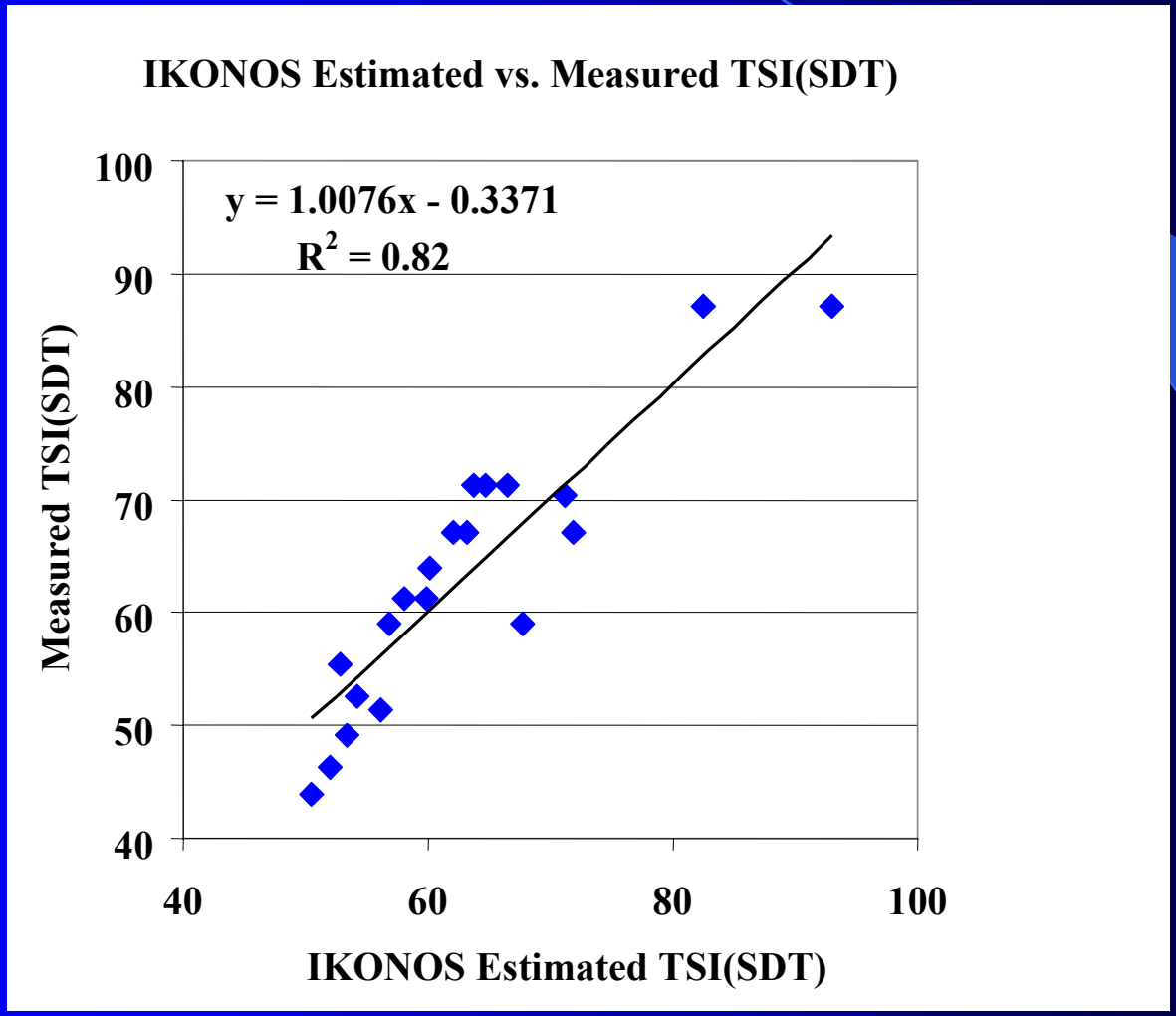
Classification of Lake Water Quality

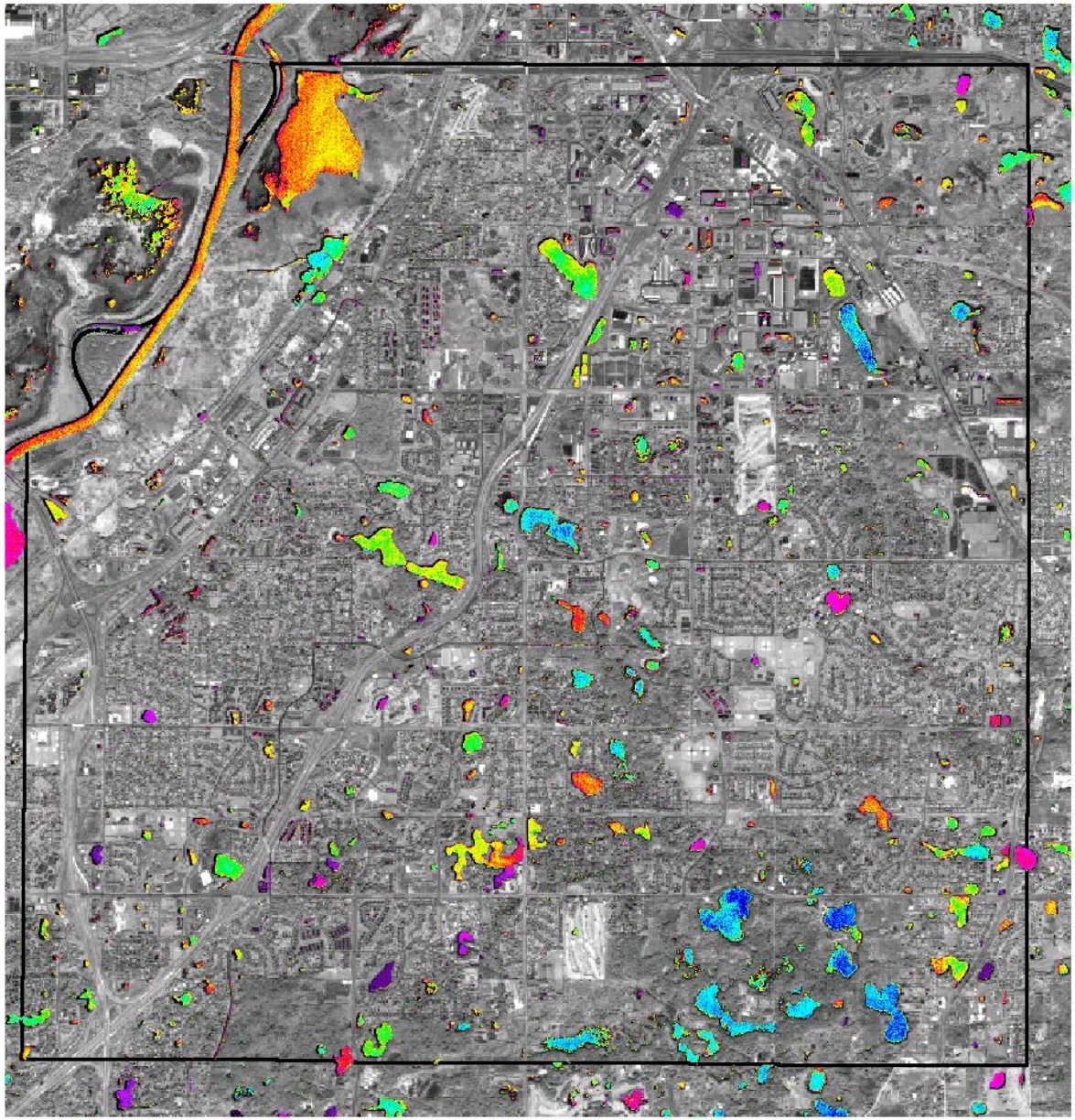
- **Location:** City of Eagan (suburb of Twin Cities Metropolitan Area)
- **Acquisition:** Two date sequence
- **Objective:** Evaluate potential for monitoring clarity of smaller lakes in an urban setting



Landsat estimation of lake water clarity for the state of Minnesota (15 Landsat TM scenes)

Relationship between *in-situ* and IKONOS data





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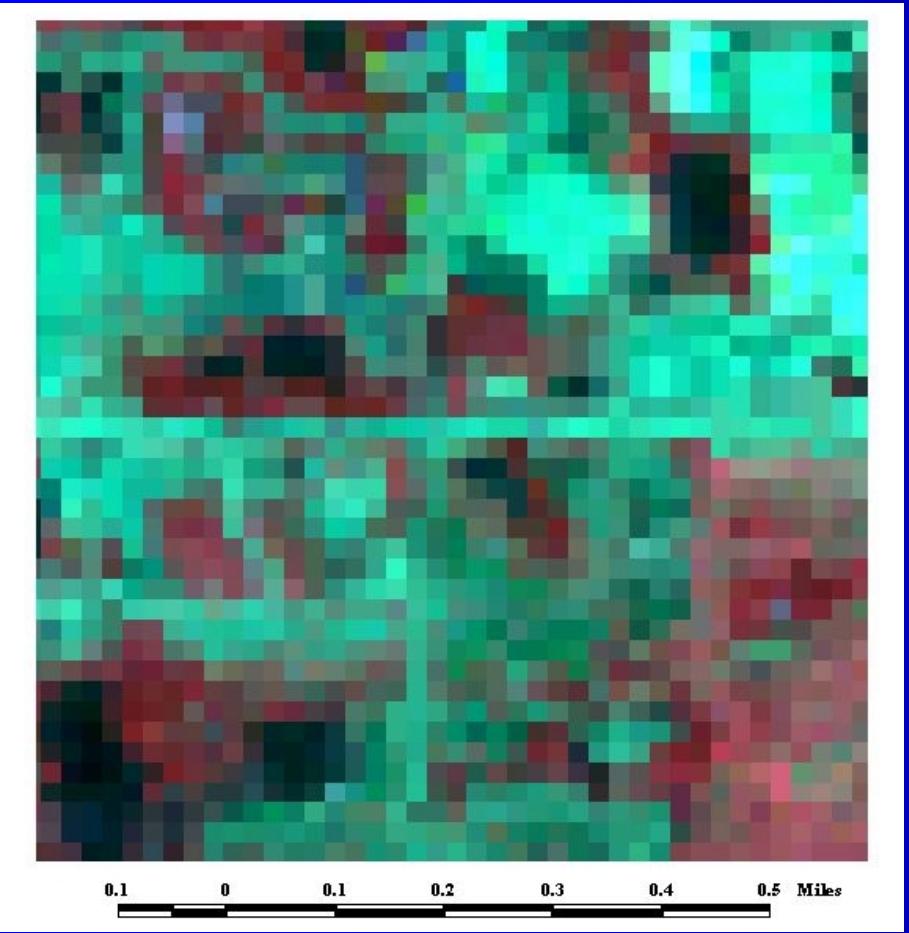
Eagan IKONOS
Lake Water Clarity
August 23, 2000

TSI(SDT)	SDT(m)
45	
50	2
55	
60	1
65	
70	0.5
75	
80	0.25
85	
90	0.125

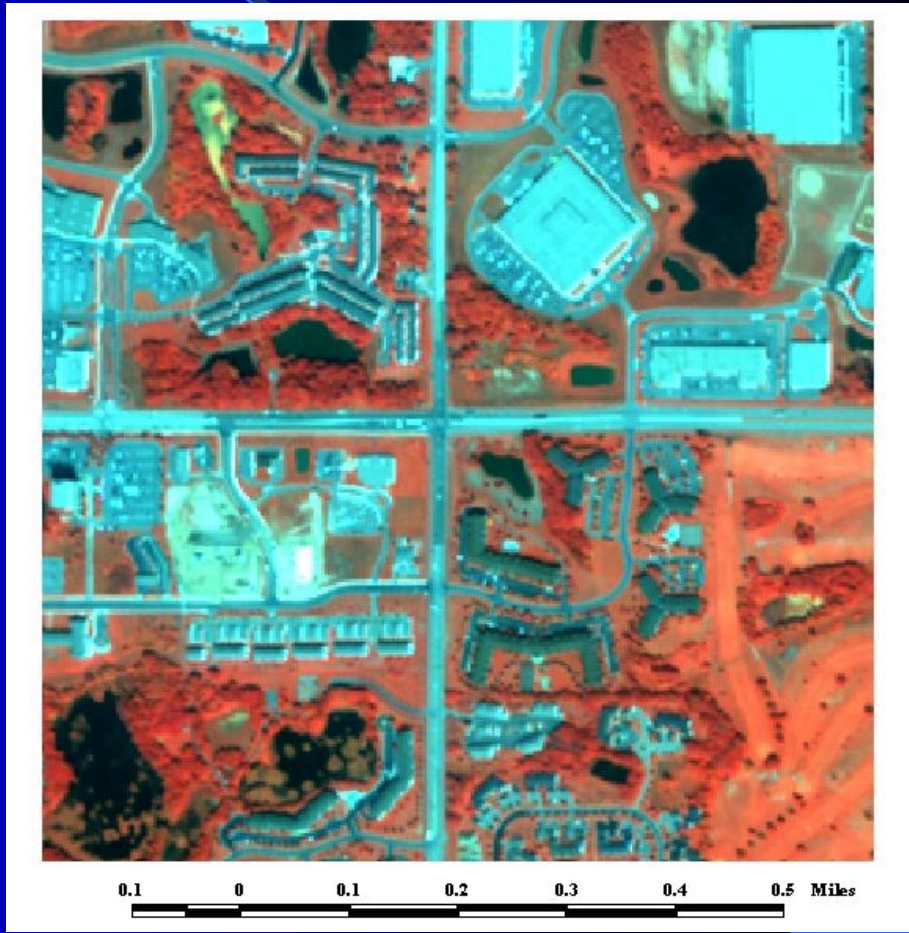
1 0 1 Miles

Landsat and IKONOS Resolution

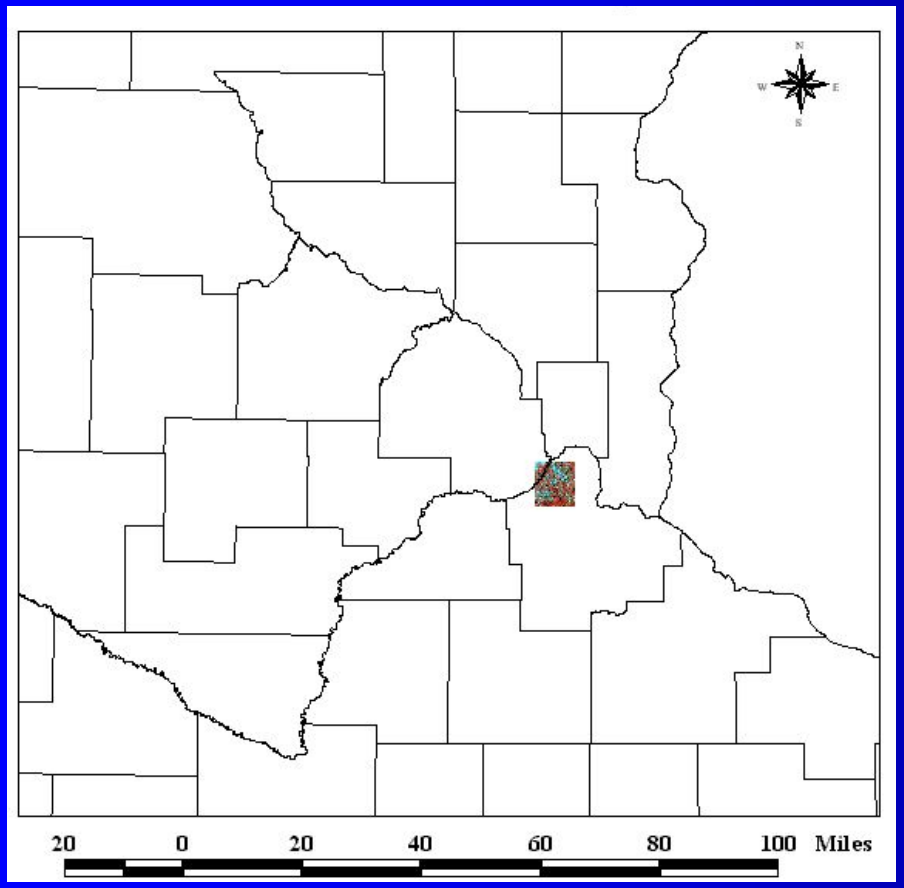
- Landsat TM, 30 meter

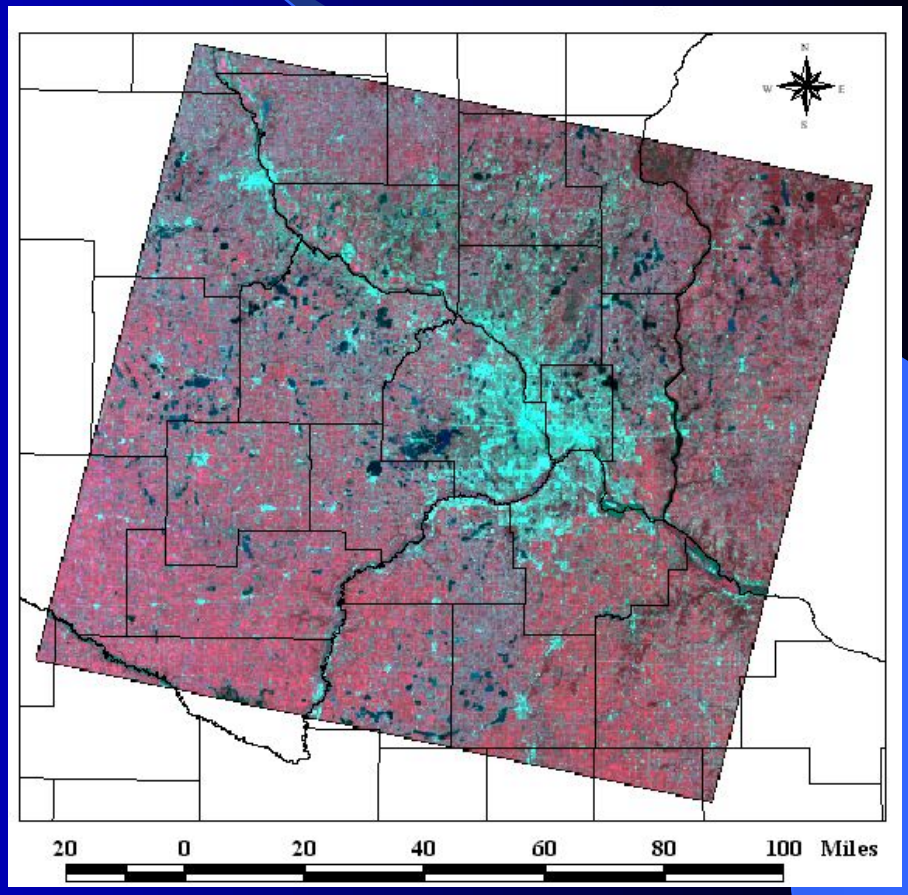


- IKONOS, 4 meter



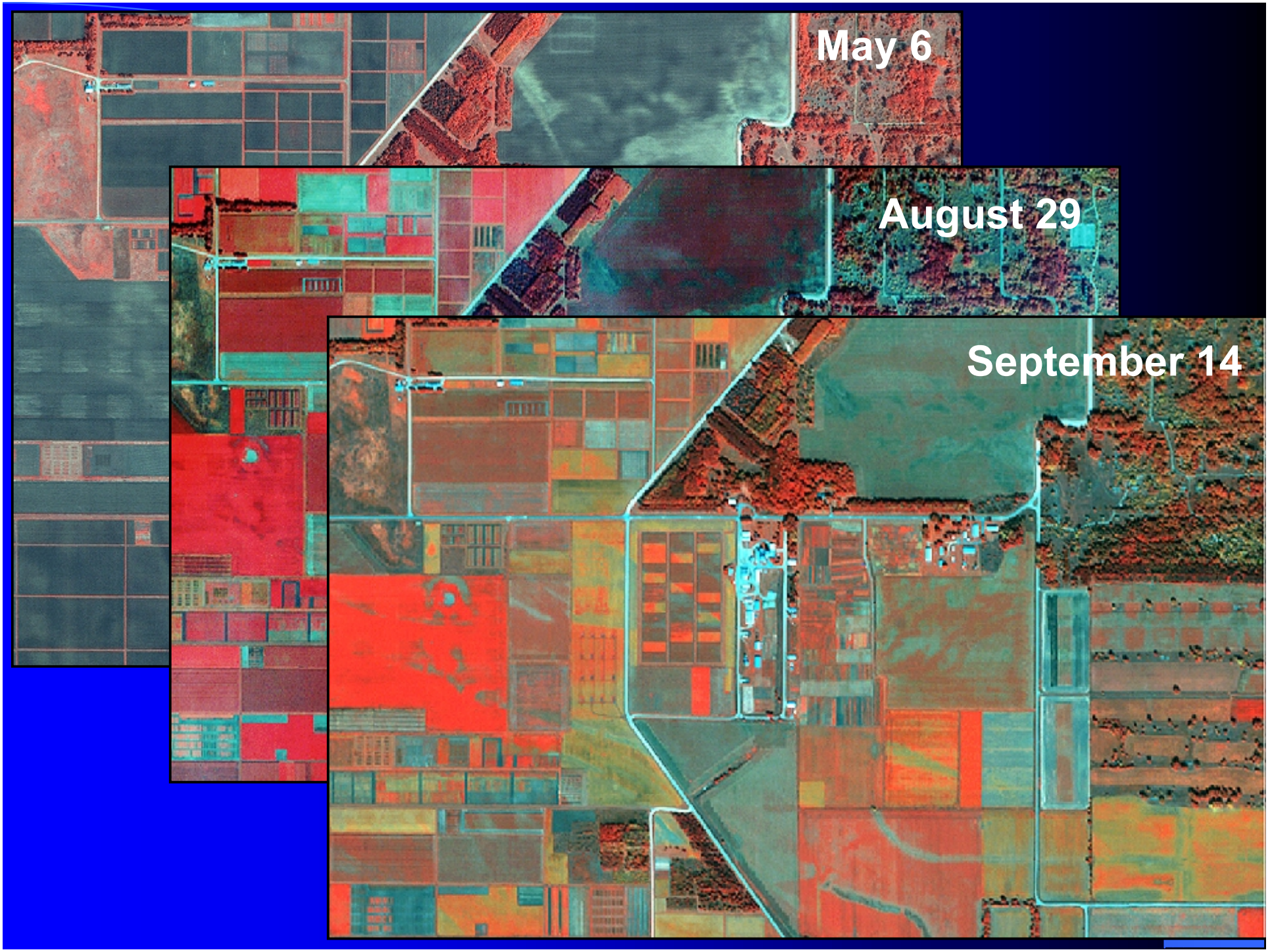
IKONOS and Landsat Coverage





Agricultural Crop Management

- **Location:** University of Minnesota Rosemount Agricultural Experiment Station
- **Acquisition:** Three-date sequence
- **Objective:** Evaluate the potential of IKONOS data for precision crop management


May 6
August 29
September 14

Data Acquisition and Timeliness Issues

- May 6 data delivered June 4
- No June or July data acquired
- August 29 data delivered October 15
- September 14 data delivered October 15

Summary: Strengths of IKONOS data

- High resolution, multispectral imagery
- Digital, ready input into GIS
- Familiar (similar to aerial photography)
- Current imagery
- Rapid delivery (possible)

Summary: Limitations of IKONOS data

- Scheduling acquisitions at desired times has proven more difficult than anticipated
- Delivery through SDP has been slow
- Problems encountered merging panchromatic with multispectral data for pan-sharpening
- Cost

Conclusion

- We have found IKONOS data to be of generally high quality with excellent potential to extend satellite remote sensing to applications beyond what has been traditionally done with aerial photography